Panama City Lab Video/Trap Reef Fish Survey

Survey history and overview: In 2004 the SEFSC's Panama City laboratory initiated a fishery-independent trap survey (the survey) of natural reefs on the inner and mid-shelf of the eastern Gulf of Mexico off northwest Florida, and in 2005 video sampling was added. The survey's primary objective is to generate indices of relative abundance of federally-managed reef fishes for stock assessments and to inform fishery managers. Target species include snappers (red, vermilion, gray, and lane), groupers (gag, red, & scamp), gray triggerfish, red porgy, white grunt, black seabass, hogfish, and amberjacks. Secondary objectives of the survey include examining community structure, annual regional catch, recruitment, distribution, and demographic patterns of economically and ecologically important reef fish species. Another objective is to map and characterize natural reef habitat in the survey region using side scan sonar in order to expand the sampling universe, determine species-habitat relationships, facilitate moving to a stratified random sampling design, and guide analyses of survey data.

The survey region spans an established hydrographic and likely zoogeographic boundary at Cape San Blas (Zieman and Zieman 1989), and has expanded geographically and bathymetrically over time. Since 2006 it has ranged from about 86º 10' W on the western edge to about 28º 45' N on its southeastern boundary. In 2013 the western boundary will be extended to 86º 30'. Minimum sampling depth has always been ~8 m, with maximum depth about 30 m through 2007, 40 m in '08 and '09, and 47 m thereafter.

Sampling effort has also increased since 2004. Sample sizes were 59 in 2004 (33 west of Cape San Blas: 26 east of Cape San Blas), 101 in '05 (24 W: 77 E), 113 in '06 (25 W: 89 E), 86 in '07 (29 W: 57 E), , 98 in '08 (31 W: 66 E), 143 in '09 (48 W: 97 E), , 162 in '10 (53 W: 109 E), and 170 in '11 (65 W: 115 E), and 174 in '12 (59 W: 115 E). In 2004 and 2005 some sites were sampled twice: 9 in 04 and 23 in 05; thereafter each site was only sampled once in a given year.

In 2008 the Florida Fish and Wildlife Conservation Commission's Fish and Wildlife Research Institute (FWRI) joined with the Panama City and Pascagoula NOAA Fisheries Service labs in an effort to expand to the entire west Florida shelf the ongoing fishery independent reef fish surveys conducted by the latter two. To maximize the comparability, value, and spatial coverage of the data being collected, every effort is being made to standardize the gear, survey design, sampling protocol, and analytical methods among the three agencies. All three groups collect visual data with stereo camera systems and Panama City and FWRI both use chevron traps.

Sampling design: The survey sampling design was systematic through 2009 because of a very limited sampling universe. When a side scan survey in early 2010 yielded an order of magnitude increase in the sampling universe, the design was changed to 2 stage random, with proportional allocation by region, sub-region, and depth (7-20, 20-30, 30+ m) to ensure uniform geographic and bathymetric coverage. The survey universe is gridded into blocks measuring 5 min of latitude by 5 min of longitude. Initially, a sample of

blocks is randomly selected. Blocks are weighted based on number of sites within them. Those with higher numbers of reefs have a higher probability of being selected. Secondly, 2 sites at least 300 m apart and two alternates are randomly selected from each selected block. In blocks containing only 1 site, the second site and alternates are randomly selected from the closest adjoining block. Individual sites are weighted using a mean value of individual ratings based on measurements of area, relief, rugosity, and proximity to other reefs derived from side scan sonar data (Table 1). Reefs with higher weighting factors have a higher probability of being selected. The few sites which have not been side scanned are assigned the average rating for the all side scanned sites in the block in which they are located. Alternates sites are used if, upon arrival, another boat is on the site or no hard bottom can be located with sonar.

Table 1. Reef metrics and associated rating values /description used on side scan images to assign weighting factors to reef fish survey sites. Overall weighting factor = average of the four metrics' ratings.

Area (m^2)	Relief (m)	Proximity to other reefs (m)	Rugosity	Rating
<250	<0.1	>150	Smooth	1
250-1000	0.1-0.32	100-150	Some roughness	2
1001-1750	0.33-0.65	<100	Very rough/complex	3
1751-2500	0.66-0.99			4
>2500	≥1.0			5

Survey protocols and methods: Sampling occurs May through early October, but primarily during June – September, and only during daytime from 1 hr after sunrise until 1 hr before sunset. Through 2008 each site was sampled with the camera array followed immediately by a single trap. Beginning in 2009 trap effort was reduced ~50%, with one deployed at about every other video site, starting with the first site of the day. This was done to increase the number of video samples, and hence the accuracy and precision of the video abundance estimates. At each site, a CTD cast was made to collect temperature, salinity, oxygen, and turbidity profiles.

Video gear is much less selective and provides abundance estimates for many more species than traps, and those estimates are usually much less biased. Annual frequency of occurrence in video collections, 2005-09, ranged up to 50.0% for gag, 72.6% for red grouper, 100.0% for red snapper, 72.0% for scamp, 73.1% for gray snapper, 92.0% for gray triggerfish, 58.1% for hogfish, and 95.2 % for white grunt. Although selective, chevron traps do effectively catch gag, red grouper, red snapper, vermilion snapper, gray triggerfish, black seabass, and white grunt; with annual percent frequency of occurrence, 2005-09, ranging up to 37.5 % for gag, 56.6% for red grouper, 88.0% for red snapper, 64.0% for gray triggerfish, and 77.4 % for white grunt.

Trapping is done with the same chevron trap used by the South Atlantic MARMAP program for over 20 yr (McGovern et. al. 1998), except that the area of the throat opening is 50% smaller. Traps, baited each set with 3 previously frozen Atlantic mackerel *Scomber scombrus,* are soaked for 1.5 hr and fished as close as possible to the location

sampled by the camera array that day. All fish are identified, counted and measured to maximum total and fork length (FL only for gray triggerfish and TL only for black seabass). Both sagittal otoliths are collected from 4-5 randomly subsampled specimens of all snappers (gray, lane, red, and vermilion), groupers (gag, red, and scamp), black seabass, red porgy, hogfish, white grunt, and gray triggerfish (first dorsal spine for the latter). These subsampled specimens are also sexed and staged macroscopically. Ageing structures are archived at the Panama City lab and aged as SEDAR priorities and scheduling dictate. All trap and video station and catch data are entered into an onsite server database and proofed. Age and reproductive data are also entered into a Panama City lab age, growth, and reproduction server database.

During 2005 – 2008, visual data were collected using a stationary camera array composed of 4 high definition (HDEF), digital video cameras mounted orthogonally 30 cm above the bottom of an aluminum frame. From 2007 to 2009, parallel lasers (100 mm spacing) mounted above and below each camera were used to estimate the sizes of fish which crossed the field of view perpendicular to the camera. In 2009 and 2010, one of the HDEF cameras was replaced with a stereo imaging system (SIS) consisting of two high resolution black and white still cameras mounted 8 cm apart, one digital video (mpeg) color camera, and a computer to automatically control these cameras as well as store the data. The SIS provides images from which fish measurements can be obtained with the Vision Measurement System (VMS) software. Beginning in 2011, a second SIS facing 180º from the other was added, reducing the number of HDEFs to two; both SIS's were also upgraded with HDEF, color mpeg cameras.

When only HDEF cameras were used (2005-08), soak time was 30 min to allow sediment stirred up by the array to dissipate and ensure tapes with an unoccluded view of at least 20 min duration (Gledhill and David 2003). With the addition of stereo cameras in 2009, soak time was increased to 45 min to allow sufficient time to ensure the hard drive in the SIS was not spinning during deployment or retrieval.

Video reading protocols: Before 2009, tapes of the 4 HDEF cameras were scanned, with the one with the best view of the habitat analyzed in detail. If none was obviously better, one was randomly chosen. In 2009 only the 3 HDEF video cameras were scanned (the 4^{th} was SIS) and the one with the best view of the reef was analyzed. Starting in 2010, all 4 cameras – the HDEFs and the SIS MPEGs, which have virtually the same fields of view (64 vs 65º) – were scanned, and again, the one with the best view of the habitat was analyzed. Twenty min of the tape are viewed, beginning when the cloud of sediment disturbed by the landing of the array has dissipated. All fish captured on videotape are identified to the lowest discernable taxon. Data on habitat type and reef morphometrics are also recorded. If the quality of the mpeg video derived from the SIS is poor (a common problem), fish id's are confirmed on the much higher quality and concurrent stereo still frames. The estimator of abundance is the maximum number of a given species in the field of view at any time during the 20 min analyzed (= min count; Gledhill and Ingram 2004), and VMS measurements are only taken from a still frame showing the min count of a given species to eliminate the possibility of measuring the same fish more than once. Even for deployments where the SIS did not provide the best

view of the reef habitat, the files are still examined to obtain fish measurements using VMS, and again, those measurements are only taken from a still frame showing the min count of a given species. In contrast, when using the scaling lasers on the array to obtain length data, there was no way to eliminate the possibility of double measuring a given fish, although this was probably not a serious problem, as usable laser hits were typically rare for any one sample.

To ensure consistency & identify issues in species id, min counts, and habitat classification within the Panama City lab survey, the first 10 tapes analyzed from a given year are read by both readers. Similarly, to ensure consistency & identify issues in species id, min counts, and habitat classification among the 3 labs involved in the West Florida shelf cooperative reef fish video survey (NMFS Panama City, NMFS Pascagoula, FWRI), readers from each lab read a sample of 10 tapes from the other 2 labs. Results from these reader/lab comparisons are presented and discussed at an annual Cooperative Survey workshop.

Analysis of video data: Censored data sets are used in deriving the indices of relative abundance from video data. Video data from all sites is screened, and those with no evidence of hard or live bottom in close proximity, no reef fish species present, as well as sites where the view was obscured for some reason (poor visibility, bad camera angle), are censored (excluded) from CPUE analyses. Inclusion of data from those sites would reduce the precision of the abundance estimates and confounded any analyses. In many cases separate analyses must be conducted for data collected on different sides of Cape San Blas because of significant differences in species composition, demographics, and abundance of many reef fishes across that zoogeographic boundary, especially in the inner and mid-shelf depths sampled by the Panama City survey.

Delta-lognormal indices of relative abundance (I_y) as described by Lo *et al*. (1992) are estimated from video min count data as

(1) $I_y = c_y p_y$,

where c_y is the estimate of mean CPUE (video min count) for positive observations only for year y; p_y is the estimate of mean probability of occurrence during year y. Both c_y and p_y are estimated using generalized linear models. Data used to estimate abundance for positive catches (c) and probability of occurrence (p) are assumed to have a lognormal distribution and a binomial distribution, respectively, and modeled using the following equations:

(2) $\ln(\mathbf{c}) = \mathbf{X\beta} + \boldsymbol{\varepsilon}$

and

(3) $\mathbf{p} = \frac{e^{\mathbf{X\beta}+\boldsymbol{\varepsilon}}}{1+e^{\mathbf{X\beta}+\boldsymbol{\varepsilon}}}$, respectively,

where **c** is a vector of the positive catch data, **p** is a vector of the presence/absence data, **X** is the design matrix for main effects, **β** is the parameter vector for main effects, and **ε** is a vector of independent normally distributed errors with expectation zero and variance σ^2.

The GLIMMIX and MIXED procedures in SAS (v. 9.1, 2004) are used to develop the binomial and lognormal submodels, respectively. Similar covariates are tested for inclusion for both submodels: water depth, survey region [two regions in the northeastern GOM: East (east of Cape San Blas) and West (west of east of Cape San Blas)], month and year. A backward selection procedure is used to determine which variables are to be included into each submodel based on type 3 analyses with a level of significance for inclusion of $\alpha = 0.05$. If year is not significant then it is forced into each submodel in order to estimate least-squares means for each year, which are predicted annual population margins (i.e., they estimate the marginal annual means as if over a balanced population).

Therefore, c_y and p_y are estimated as least-squares means for each year along with their corresponding standard errors, SE(c_y) and SE(p_y), respectively. From these estimates, I_y is calculated, as in equation (5), and its variance calculated as

$$(4) \qquad V(I_y) \approx V(c_y)p_y^2 + c_y^2 V(p_y) + 2c_y p_y \mathrm{Cov}(c, p),$$

where

$$(5) \qquad \mathrm{Cov}(c, p) \approx \rho_{c,p}\left[\mathrm{SE}(c_y)\mathrm{SE}(p_y)\right],$$

and $\rho_{c,p}$ denotes correlation of *c* and *p* among years.

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